Master of Technology

In

Civil Engineering (Geotechnical)

Course Structure & Syllabus

Civil Engineering Department

National Institute of Technology Hamirpur

Hamirpur (HP) – 177005, India

Course Structure of M. Tech. Civil Engineering (Geotechnical)

SEMESTER-I

Sr. No.	Course No.	Course Name	Teaching Schedule			Hours /week	Credit
			L	T	P		
1	CE -631	Advanced Soil Mechanics	4	0	0	4	4
2	CE -632	Advanced Foundation Engineering	4	0	0	4	4
3	CE -633	Soil Dynamics	4	0	0	4	4
4	CE-7MN	Programme Elective-I	4	0	0	4	4
5	CE-7MN	Programme Elective-II	4	0	0	4	4
6	CE -634	Computing in Geotechnical Engg. Lab	0	0	4	4	2
	Total		**20**	**0**	**4**	**24**	**22**

Programme Elective - I & II: List of Programme Electives is given in the Annexure.

SEMESTER-II

Sr. No.	Course No.	Course Name	Teaching Schedule			Hours /week	Credit
			L	T	P		
1	CE -641	Underground Excavations in Rocks	4	0	0	4	4
2	CE -642	Machine Foundations	4	0	0	4	4
3	CE -643	Exploration and Field Testing	4	0	0	4	4
4	CE-7MN	Programme Elective-III	4	0	0	4	4
5	CE-7MN	Programme Elective-IV	4	0	0	4	4
6	CE-644	Advanced Geotechnical Engineering Laboratory	0	0	4	4	2
	Total		**20**	**0**	**4**	**24**	**22**

Programme Elective – III & IV: List of Programme Electives is given in the Annexure.

SEMESTER-III

Sr. No.	Course No.	Course Name	Hours/week	Credit
1	CE-800	M.Tech. Dissertation	--	20
	Total			**20**

SEMESTER-IV

Sr. No.	Course No.	Course Name	Hours/week	Credit
1	CE-800	M.Tech. Dissertation	--	20
	Total		**--**	**20**

Total Credit of the Programme = 84

Annexure
List of Programme Electives

Programme Elective-I

CE-731	Earth Pressure and Retaining Structures
CE-732	Geo-environmental Engineering
CE-713	Computation Techniques in Civil Engineering
CE-714	Earth Dams
CE-715	Environmental Impact Assessment

Programme Elective-II

CE-736	Hazardous Waste and Remediation of Contaminated Sites
CE-737	Ground Improvement Techniques
CE-718	GIS and its Application In Civil Engineering
CE-719	Disputes and Arbitration in Engineering Projects

Programme Elective-III

CE-741	Soil-Structure Interaction Analysis
CE-742	Design of Substructures
CE-723	Disaster Management
CE-724	Finite Element Method

Programme Elective-IV

CE-745	Reinforced Soil Structures
CE-746	Rock Slope Engineering
CE-727	Optimization Methods
CE-728	Project Planning and Scheduling

Course Name: **Advanced Soil Mechanics**
Course Code: **CE-631**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about the engineering properties of soils with a focus on consolidation and shear strength
- To introduce the fundamental concepts relevant to the strength behaviour of soils
- To enable the students to understand the factors that control the strength behaviour of the soils

Course Content

Introduction: Origin, Nature and distribution of soils, Description of individual particle, Clay mineralogy, clay-water-electrolytes, Soil fabric and structure. Effective stress and permeability: Effective stress principle, Steady state flow in soils, Effect of flow on effective stress, Determination of coefficient of permeability. Consolidation: Consolidation, one, two, three and radial consolidation, Variation of effective stress during consolidation, Various consolidation tests and determination of parameters. Shear strength: Stress-path, Triaxial and direct shear tests, Shear behaviour of granular soils. Factors affecting shear behaviour, Determination of parameters, Shear behaviour of fine grained soils, Pore pressure parameters, UU, CU, CD tests, Total and effective stress-strength parameters, Total and effective stress-paths, Water content contours, Factors affecting strength such as stress history, rate of testing, structure and temperature, Anisotropy of strength, thixotropy, creep, Determination of in-situ undrained strength. Stress-strain characteristics of soils, Determination modulus values, Critical state model, Engineering Behaviour of soils of India such as Black cotton soils, alluvial silts and sands, laterites, Collapsible and sensitive soils, aeolin deposits.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Describe the behaviour of the soils

CO2: Apply principles of advanced soil mechanics to civil engineering problem

Books and References

1. Soil Mechanics Fundamentals by Muni and Bhudu, John Wiley & sons.
2. Basic and Applied Soil Mechanics by Gopal Ranjan & A. S. R. Rao, New Age International Pvt Ltd.
3. Advanced Soil Mechanics by Braja M Das, CRC Press.
4. Soil Mechanics and Foundation Engineering by Dr. K. R. Arora, Standard Publisher Dist.

Course Name: **Advanced Foundation Engineering**
Course Code: **CE-632**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about the various types of shallow foudations and their bearing capacity equations
- To impart knowledge about settlement analysis of shallow footings
- To impart knowledge about the various types of deep foudations and their bearing capacity equations
- To impart knowledge about settlement analysis of deep footings

Course Content

Shallow Foundation: Terzaghi's bearing capacity equation, General bearing capacity equation, different bearing capacity theories, I.S. Code method, Effect of foundation shape, eccentricity and inclination of load, Influence of soil compressibility and water table, Footing pressure for settlement on sand, Soil pressure at a depth, Boussinesq's & Westergaard methods, Raft Foundation: Settlement and Bearing Capacity analysis, Analysis of flexible and rigid raft as per IS codes, Computation of settlements (Immediate & Consolidation), Permissible settlements, Allowable total and differential settlement of structures. Proportioning of footing, Inclined & Eccentric loads. Settlement of footings on stratified deposits. Influence of adjacent footings, Bearing Capacity from SPT and SCPT and Plate load Test data, Proportioning of footing based on settlement criteria, Foundations on Problematic soils - Problems and Remedies.

Deep Foundation: Modes of failure, Bearing capacity and settlement of pile foundation, Types of piles, Allowable load, Pile Load test, Dynamic and static formulae, Bearing Capacity factors, Pile group bearing capacity and settlement, Behavior of piles under lateral loading, Winkler's assumption, Pile resistance and deflection under lateral loads, elastic method, Broms method, Well Foundation, Bearing capacity, settlement and lateral resistance, Tilts and shifts, Drilled Shaft, Construction procedures, Design Considerations, Load Carrying Capacity and settlement analysis.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Make an assessment of the bearing capacity of the shallow and deep foundations on various types of soil conditions

Books and References

1. Foundation Design Principles and Practice by D.P. Coduto, Pearson Education India.
2. Principles of Geotechnical Engineering by Braja M. Das, Thomson.
3. Principles of Foundation Engineering by Braja M Das, Cengage Learning Custom Publishing.

Course Name: **Soil Dynamics**
Course Code: **CE-633**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about various types of vibrations and vibration measuring instruments.
- To introduce the analysis and concepts of vibration response analysis.
- To enable the students to evaluate dynamic soil parameters, dynamic earth pressure, dynamic bearing capacity of soils, dynamic stiffness of pile and liquefaction characteristics of soil.

Course Content

Fundamentals of vibrations: Response of SDOF systems, Free vibration, Experimental determination of natural frequency and damping, Response of system to exciting forces and ground motions ranging from simple pulse like excitation to harmonic and complex histories, Transmissibility, Vibration measuring instruments, Response of 2 DOF and Multi degree of freedom systems, Propagation of seismic waves in soil deposits - Attenuation of stress waves, Stress-strain behaviour of cyclically loaded soils, Strength of cyclically loaded soils, Dynamic soil properties - Laboratory and field testing techniques, Selection of design values. Dynamic earth pressure, Earthquake load on footing, effect of horizontal load and moment, provision of relevant standards, dynamic analysis for vertical and horizontal loads, Dynamic stiffness of single pile and pile group. Liquefaction studies in triaxial shear and oscillatory simple shear, evaluation of liquefaction potential, liquefaction analysis from standard penetration test data, Studies on shake table and field test.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: To know various types of vibrations and vibration measuring instruments.
CO2: To learn the response of various types of systems.
CO3: To assess the prorogation of waves through different media.
CO4: To evaluate dynamic soil parameters.
CO5: To determine the dynamic earth pressure and dynamic bearing capacity of soils.
CO6: To estimate dynamic stiffness of pile and pile groups.
CO7: To interpret the liquefaction characteristics of soil in laboratory and in the field.

Books and References

1. Soil Dynamics by Shamsher Prakash, McGraw Hill Higher Education.
2. Soil Dynamics by Swami Saran Pvt LTD, New Delhi.
3. Geotechnical Engineering by C. Venkatramaiah, New Age International Publishers.

Course Name: **Computing in Geotechnical Engineering Lab**
Course Code: **CE-634**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide basic knowledge on how to implement software for solving practical and research related problems.
- To provide skills for writing program and using MATLAB, GIS/Arc-GIS, ANSYS, PLAXIS, FLAC, ABAQUS, GEO5.
- To enable and motivate the students perform analysis using software for various research works and projects.

List of Experiments

1. MATLAB:
    a. Introduction and Fundamentals concepts of MATLAB Programming.
    b. Application to Geotechnical Engineering.
        I. An abstract idea and application of FFN/MLP (Feed Forward Network/Multilayer Perception)
        II. An abstract idea and application of RBFNN (Radial Basis Function Neural Network).
        III. An abstract idea and application of ANFIS (Adaptive Neuro-Fuzzy Inference System).
2. Arc-GIS:
    a. Geo-referencing.
    b. Digitizing and shape-file creation.
    c. Mapping, DEM.
3. ANSYS:
    a. Basic design problems of shallow and deep foundations.
    b. Analysis of retaining structures and slope stability problems.
4. PLAXIS, FLAC, ABAQUS, GEO5:
    a. Introduction to PLAXIS, FLAC, ABAQUS, GEO5.
    b. Basics of mesh generation.
    c. Slope stability analysis.
    d. Analysis of foundations and tunnels.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Perform MATLAB, GIS/Arc-GIS, ANSYS, PLAXIS, FLAC, ABAQUS, GEO5.

CO2: Design and develop programming skills, GIS maps.

CO3: Analyze and design geotechnical structures.

Course Name: **Underground Excavation in Rocks**
Course Code: **CE-641**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

1. Make theoretical calculations and engineering assessments of in situ and induced stresses before and after opening formation
2. Understand the practical approaches in designing support system for underground openings
3. Analyze the tunnel face stability
4. Learn about the design procedures for dealing with structurally controlled instabilities in underground openings

Course Content

Classification: Classification of rock and rock masses, Rock properties and their measurement

Stresses in rocks: State of stress in the ground, In-situ stress, various methods of stress measurement, Hydro-fracturing technique, Flat jack technique, Overcoring technique.

Failure Theories: Failure criteria for rock and rock masses, Mohr-Coulomb Yield Criterion, Hoek-Brown Criterion, Tensile Yield Criterion, Strength of discontinuities.

Underground openings and support system: Underground openings, size and shapes, support systems.

Stress distribution around openings: Stresses distribution around single openings, Stress distribution around multiple openings, Stresses and deformations around tunnels and galleries with composite lining due to internal pressure.

Design of underground openings: Design based on empirical methods such as RSR, RMR, Q systems, Design based on Rock support interaction analysis, Observational method- NATM, Convergence-confinement method, Key block analysis, Stability of excavation face and Tunnel portals.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Learn the methods to make assessment of the properties of rock and rock masses

CO2: Learn the design of underground openings in varying ground conditions

Books and References

1. Introduction to Rock Mechanics by Richard E. Goodman, John Wiley & Sons Inc.
2. Underground excavation in rock by Hoek and Brown, E & FN Spon.
3. Engineering Rock Mechanics: An Introduction to the Principles by J. A. Hudson & J.P. Harrison, Elsevier Science & Technology.

Course Name: **Machine Foundations**
Course Code: **CE-642**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about various types of vibration modes of foundations.
- To introduce the analysis and concepts of different types of foundations using conventional and advanced techniques.
- To enable the students to design foundations for reciprocating, impact and rotary machines.

Course Content

General view of machine vibration, vertical sliding, rocking, yawing vibrations of a block, simultaneous, sliding and vertical vibrations of a block, Dynamic stiffness of foundation - Circular rigid mat foundation on elastic half space excited vertically, laterally, torsion or rocking, Effective stiffness and damping of such systems, Modelling of soil medium by frequency dependent and frequency independent elements, Effect of soil material damping and shape, Basic principles of design of machine foundations, types of foundations, Degree of freedom of machine foundation, Foundation analysis: static and dynamic analysis, Effect of foundation embedment, Finite soil layer and depth to bedrock on system of rigid foundations, Indian standard for design of foundations for reciprocating machines and impact type of machines. Analysis and design of concrete foundation, block foundations for reciprocating engines, Low speed rotary machines, Forge hammers and frame foundations for high speed rotary machineries.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: To know about different vibration modes of foundations.
CO2: To learn the analysis of different types of foundations using conventional and advanced techniques.
CO3: To assess dynamic soil parameters for use in foundation design.
CO4: To proportion and design foundations for reciprocating, impact and rotary machines.
CO5: To understand the design concepts of low speed rotary machines.

Books and References

1. Machine Foundations by Shamsher Prakash & V. K. Puri, John Wiley & Sons.
2. Design of Structures and Foundations for Vibrating Machines by Arya and O'Niell and Pincus,, Gulf Pub Co.
3. Handbook of Machine Foundations by P. Srinivasulu & C.V Vaidyanathan Tata McGraw-Hill Education

Course Name: **Exploration and Field Testing**
Course Code: **CE-643**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about soil investigation techniques.
- To introduce the boring techniques and assessment of bearing capacity.
- To enable the students to learn various techniques of soil and rock sampling and prepare the soil and rock testing reports.

Course Content

Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic refraction methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties. Report writing, Safety measures.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: To know about different soil investigation techniques.
CO2: To learn the various methods of boring and drilling.
CO3: To assess the bearing capacity of soil using different field tests.
CO4: To learn about various techniques of soil and rock sampling.
CO5: To prepare the soil and rock testing reports.

Books and References

1. Engineering in Rocks by T. Ramamurthi, PHI Learning Private Limited.
2. Design of Sub-structures by Swami Saran, Oxford & IBH Publishing Co. Pvt. LTD.
3. Geotechnical Engineering Investigation Handbook by Roy E. Hunt, CRC Press.

Course Name: **Advanced Geotechnical Engineering Laboratory**
Course Code: **CE-644**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To train the students for collection of soil and rock specimens for testing in the laboratory.
- To provide skills for determining soil and rock properties in laboratory and in the field.
- To enable the students to assess design soil and rock parameters.
- To make the students determine the safe bearing capacity of soil and rock.

List of Experiments

1) Determination of consolidation properties of the given clay sample.
2) Direct shear test on granular soil sample.
3) Laboratory vane shear test on given soil sample and in- situ vane shear test.
4) Unconfined compression test on given soil sample.
5) Unconsolidated undrained (UU), consolidated undrained (CU) and consolidated drained (CD) triaxial shear test on the given soil sample.
6) Determination of free swell index and swelling pressure of given clay sample.
7) Brazilian test, point load test and unconfined compressive strength test on rock core.
8) Collection of undisturbed and representative samples, soil samples using auger boring and by drilling bore hole.
9) Measurement of earth pressure.
10) Bearing capacity of soil using dynamic cone penetration test, static cone penetration test and standard penetration test.
11) Bearing capacity of soil using plate load test.
12) Pressure meter test on given soil sample.
13) Determination of safe load using pile load test.
14) Block vibration test on given soil sample.
15) Liquefaction potential test on given soil sample.

Course Outcomes

Upon successful completion of the course, the students will be able to Collection of soil specimens from the field.

CO1: Interpret settlement, shear strength and swell characteristics of soil..
CO2: Assess the strength parameters of rock.
CO3: Determine safe bearing capacity of soil and rock.
CO4: Estimate load carrying capacity of pile.
CO5: Assessment of earth pressure.
CO6: Evaluate dynamic soil parameters and liquefaction characteristics.

Course Name: **Earth Pressure and Retaining Structures**
Course Code: **CE-731**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about the various earth pressure concepts
- To analyses the stability of various earth retaining structures under loads
- To learn the geotechnical design of retaining structures

Course Content

Earth Pressure: Earth Pressure Types, Rankine's theory, Backfill features – soil type, surface inclination, loads on surface, soil layers, water level, Coulomb's theory, Effects due to wall friction and wall inclination, Graphical methods, Earthquake effects.

Rigid Retaining Structures: Rigid Retaining Structures, Types, Empirical methods and Stability analysis.

Flexible Retaining Structures: Flexible Retaining Structures, Types, Material, Cantilever sheet piles, Anchored bulkheads, free earth method, fixed earth method, moment reduction factors, anchorage, Braced Excavation Types, Construction methods, Pressure distribution in sands and clays.

Underground structures in soils: Underground structures in soils such as pipes, conduits and trenches.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the earth pressure concepts and shall be able to analyse and design the earth retaining structure

Books and References

1. Earth pressure and earth retaining structures by Clayton, Milititski and Woods, Taylor & Francis Group, London.
2. Principles of Geotechnical Engineering by Braja M. Das, Thomson
3. Soil Mechanics and Foundation Engineering by Dr. K. R. Arora, Standard Publisher Dist.

Course Name: **Geo-environmental Engineering**
Course Code: **CE-732**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

1. Understand the geoenvironmental issues at global, regional, and local levels
2. Familiarize with the current environmental problems
3. Identify the Sources of wastes and options available for Waste management
4. Landfill design and considerations
5. Geosynthetics and natural Geotextiles and their role in geoenvironmental engineering
6. Expose themselves to real geoenvironmental problems, and link them with the community and the industry

Course Content

Introduction: Introduction to Geo environmental engineering, environmental cycle, sources, production and classification of waste, causes of soil pollution, factors governing soil-pollutant interaction, Safe disposal of waste.

Contaminant Transport: Contaminant transport in sub surface, advection, diffusion, dispersion, governing equations, contaminant transformation, sorption, biodegradation and ion exchange.

Landfill design and considerations: Precipitation, hydrological consideration in land fill design, site selection for landfills, characterization of land fill sites, waste characterization, stability of landfills, current practice of waste disposal, passive containment system.

Geosynthetics in environmental geotechnics: Application of geo synthetics in solid waste management, rigid or flexible liners, bearing capacity of compacted fills, foundation for waste fill ground.

Ground water pollution:– Ground water pollution, pollution of aquifers by mixing of liquid waste, protecting aquifers.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Learn the design of landfills and shall be able to handle the geo-environmental problem in actual practice

Books and References

1. Waste disposal in engineered landfills by Manoj Dutta, Narosa Publishing House.
2. Geosynthetics and Their Applications by S. K. Shukla and J.H Yin, CRC Press.
3. Solid Waste Management: Principles and Practice by Ramesha Chandrappa & Diganta Bhusan Das, Springer.

Course Name: **Computation Techniques in Civil Engineering**
Course Code: **CE-713**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To provide an introduction to the basic principles, techniques, and applications of soft computing.
- To provide the mathematical background for carrying out the optimization associated with neural network learning
- To impart the skills of using soft computing in research problems

Course Content

Introduction: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms

GA: Gene, Chromisome, Allele, Schemata Theory, genotype, phenotype, competition and selection – different types, Crossover – different techniques, elitism, mutation – different types, stopping criteria, Flow chart of GA.

Evolutionary Algorithm: Simulated annealing, Evolutionary programming, hill climbing

Fuzzy: Membership function, fuzzyfication, fuzzy operator, interference rules, defuzzyfication, exploration and exploitation

PSO, Ant colony optimization

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply soft computing techniques in research problems

Books and References

1. Neuro-Fuzzy and Soft Computing by J.S.R.Jang, C.T.Sun and E.Mizutani, Pearson Education.
2. Artificial Neural Network by Simon O. Haykin, PHI.

Course Name: **Earth Dams**
Course Code: **CE-714**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about different types of dams and their basic design requirements.
- To introduce the analysis and concepts of seepage, stability and failure mechanism of dams.
- To enable the students to design different dam components.

Course Content

Classification of dams, Selection of site, Basic design requirements, Preliminary section, Seepage through dam section and its control, fundamentals of seepage flow, flow nets, Seepage through foundation, seepage control, filters, impervious core, drainage, foundation trench cutoff, upstream impervious blanket, horizontal drainage blanket, relief wells, drainage trenches, cut-off walls, downstream loading berm, Foundation treatment such as treatment of pervious, impervious and rock foundations, core contact treatment, grouting, foundation excavation. Stability analysis: critical slip surfaces, test conditions, strength parameters, pore pressures, stability analysis-method of slices, Bishops method, Morgenstern- price method, Janbu method. Construction of earth dams: construction equipment, procedures for pervious, semi-pervious, impervious and rock fill sections, construction supervision. Failures and damages of earth dams: nature of failures – piping, settlement cracks, slides, earthquake & miscellaneous damages.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: To know different types of dams, their basic design requirements and loads imposed.
CO2: To learn the analysis of dams.
CO3: To assess the seepage through earth dams and seepage control measures.
CO4: To proportion and design different types of dams.
CO5: To perform stability analysis and foundation treatment in dams.
CO5: To assess the construction aspects and design procedures of different dam components.
CO6: To evaluate the causes and mechanism of failure of earth dams.

Books and References

1. Design of Earth Dams by A.L. Goldin, CRC Press.
2. Earth and Rockfill Dams: Principles for Design and Construction by Christian Kutzner, CRC Press.
3. Geotechnical Engineering of Dams by Robin Fell, Patrick MacGregor, David Stapledon, Graeme Bell, Mark Foster, CRC press.

Course Name: **Environmental Impact Assessment**
Course Code: **CE-715**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To understand the concepts of ecology, sustainable development and EIA.
- To explore current EIA process in India.
- To acquire knowledge about various methods for conducting EIA, Environmental Legislation & Environmental Audit

Course Content

Environmental management- problems and strategies - Review of political, ecological and remedial actions - future strategies - multidisciplinary environmental strategies decision making and concepts of sustainable development. Concept of environmental audit - Life Cycle Analysis (LCA) - Environmental Management System - Introduction to ISO 14000, OSHA and Clean Development Mechanism (CDM) & Carbon credits. Introduction to various major natural disasters - flood, tropical cyclone, droughts, landslides, heat waves, earthquakes, fire hazards, tsunami etc., Factors for disaster - climate change, global rise in sea level, coastal erosion, environmental degradation, large dams, Legislative responsibilities of disaster management. Environmental legislation of Air, Water & Hazardous Waste - Environment Protection Act-1986 - Regulatory standards of CPCB / GPCB / BIS - EIA need and Notification - Environmental clearance. Introduction and Planning: Evolution of Environmental Impact Assessment - concepts of EIA - EIA methodologies screening and scoping - rapid and comprehensive EIA - General framework of EIA - characterization and site assessment - Environmental inventory - Prediction and assessment of impact - Impact assessment methodologies like adhoc method, checklist, overlap, network, model and index method. Decision methods of evaluation of alternatives - development of decision matrix - Public participation in environmental decision making - Objective of public participation -Technique for conflict management and dispute resolution- Verbal communication and Public Hearing in EIA studies - Status of EIA in India - Some typical case studies of EIA industrial and infrastructure projects.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO 1: Understand the importance & concepts of carrying out EIA.
CO 2: Acquire knowledge about current EIA process in India.
CO 3: Acquire knowledge about various methods & data requirements for conducting EIA.
CO 4: Analyze Impact's associated with various components of environment.
CO 5: Plan for mitigation of the impacts & monitor the mitigation measures.
CO 6: Acquire knowledge about Environmental Legislation & Environmental Audit.

Books and References

1. Environmental Impact Assessment by Larry W. Canter, Tata Mcgraw Hill Co.
2. Environmental Impact Analysis by R. K. Jain, L. V. Urban & G. S. Stacey, Van Nostrand Reinhold Company.
3. Environmental Impact Assessment by R. E. Munn, John Wiley & Sons, Toronto.
4. Environmental Engineering and Management by Suresh K. Dhameja, S. K. Kataria & Sons.
5. Relevant MoEF Notifications and CPCB / GPCB Acts & Rules.

Course Name: **Hazardous Waste and Remediation of Contaminated Sites**
Course Code: **CE-736**
Course Type: **Programme Elective II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

1. Understand the hazardous waste issues at global, regional, and local levels
2. Familiarize with the current environmental problems
3. Identify the Sources of hazardous wastes
4. Learn contaminated sites remediation techniques

Course Content

Hazardous Waste: Hazardous waste control and storage system, stabilization/ solidification of hazardous wastes, mechanism of stabilization – organic and inorganic stabilization – utilization of solid waste for soil improvement. Encapsulation: Micro and macro encapsulation, absorption, adsorption, precipitation and detoxification.
Remediation of contaminated sites: Rational approach to evaluate and remediate contaminated sites, monitored natural attenuation, exsitu and insitu remediation, solidification, bio–remediation, incineration, soil washing, electro kinetics, soil heating, verification and bio venting. Ground water remediation: – Ground water remediation, pump and treat, air sparging and reactive well.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Learn the sources of hazardous waste and remediation techniques of contaminated sites and ground water.

Books and References

1. Chemical Kinetics & Process Dynamics in Aquatic Systems by Brezonik, McGraw-Hill Co.
2. Contaminant Hydrogeology by Fetter, Charles W. Jr., Macmillan Publishing Co.
3. Hazardous Waste Management by La Grega, Michael, McGraw-Hill Co.
4. Solid Waste Management, Engineering Principles and Management Issues, McGraw-Hill, Inc.
5. Handbook of Chemistry and Physics, CRC Press, any of the past fifteen years.

Course Name: **Ground Improvement Techniques**
Course Code: **CE-737**
Course Type: **Programme Elective II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

1. Know about the methods and design of right kind of ground improvement techniques required for the actual field situation

Course Content

Compaction: Principles of compaction, Laboratory compaction, engineering behaviour of compacted clays, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control, Vibro-floatation, dynamic compaction.

Shallow stabilisation: Shallow Stabilization with additives such as Lime, flyash, cement and other chemicals and bitumen.

Deep stabilization: Sand column, stone column, sand drains, prefabricated drains, electro-osmosis, lime column, soil-lime column.

Grouting: Permeation, grouting, thermal, freezing, Dewatering systems.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Choose the right kind of ground improvement techniques required for the actual field situation

Books and References

1. Ground Improvement by M.P. Moseley and K. Kirsch, Spon Press.
2. Ground Control and Improvement by Petros P Xanthakos, Lee W Abramson and Donald A Bruce, Wiley-Interscience.
3. Ground Improvement Techniques by P. Purushothama Raj, Laxmi Publications.
4. Ground Improvement by Klaus Kirsch & Alan Bell, CRC Press.

Course Name : **GIS and its application in civil engineering**
Course Code : **CE-718**
Course Type : **Programme elective II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- Understanding the need of CAD and GIS,
- Understanding map projection and working with coordinate systems,
- Understanding vector-based and raster-based data data analysis,
- Review of application areas of GIS in Civil Engineering, and
- Understanding basic principles of remote sensing.

Course Content

Basics of remote sensing: Introduction to Remote Sensing, data acquisition and processing, Electromagnetic Radiation (EMR) and its characteristics, Radiation principles, prosperities of solar radiant energy, atmospheric windows. Interaction in the atmosphere, nature of atmospheric interaction, atmospheric effects of visible, near infra-red thermal and microwave wavelengths, interaction at ground surface, interaction with soils and rocks, effects of soil moisture, organic matter, particles, size and texture, interaction with vegetation, spectral characteristics of individual leaf, vegetation canopies, effect of leaf pigments, radiation geometry.

Introduction with GIS: Def. of GIS, Difference between GIS and CAD worlds, utility of GIS, various GIS packages and their salient features, essential components of a GIS, scanners and digitizers.

Map projection and coordinate systems: Introduction, geographic Grid, Map projection, Coordinate systems.

Vector data models and Analysis: vector data and its representation, topological data structure, non-topological vector data structure, TIN, Region, vector data editing and analysis.

Raster data models and Analysis: acquiring and handling of raster data storage, function of raster based GIS data analysis. Engineering applications of GIS: applications of GIS in civil engineering.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the principles of remote sensing,
CO2: Understand the principles of geographic information systems,
CO3: Apply remote sensing and GIS to solving problems of Civil Engineering,
CO4: Maximize the efficiency of planning and spatial decision making, and
CO5: Integrate geographically referenced data and develop queries to generate usable information.

Books and References

1. Remote Sensing and Image Interpretation: T.M. Lillensand and R.W. Keifer, John Wiley and Sons.
2. Principles of Remote Sensing : P.J. Curren, Taylor & Francis Online.
3. Concept and Techniques of Geographical Information systems : C.P. Lo and Albert K.W.Yeung, Taylor & Francis Online.
4. Introduction to Geographical Information systems: Kang-tsung Chang, McGraw-Hill Higher Education.
5. Geographical Information systems- A Management Perspective : Stan Aromoff, Taylor & Francis Online.

Course Name: **Disputes and Arbitration in Engineering Projects**
Course Code: **CE-719**
Course Type: **Programme Elective II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about avoidance of disputes and conflicts and wastage of time and Resources
- To enable students to be involved in the process of Conflict avoidance, management and Dispute resolution in construction projects.
- To understand range of dispute resolution techniques including Adjudication and Arbitration proceedings.
- To enable the student to understand conflict management and dispute resolution procedures including negotiation, mediation and conciliation, adjudication, arbitration and litigation.

Course Content

Project cost estimation, rate analysis, overhead charges, bidding models and bidding strategies. Owner's and contractor's estimate.
Pre-qualification of bidders and enlistment of contractors.
Tendering and contractual procedures, Indian Contract Act 1872, Definition of Contract and its applicability, Types of contracts, International contracts, FIDIC, Conditions and specifications of contract.
Contract administration, Duties and responsibilities of parties Claims, compensation and disputes, Dispute resolution techniques, Arbitration and Conciliation Act 1996, Arbitration case studies, Negotiation

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the underlying causes of most conflicts and disputes and demonstrate knowledge and understanding the techniques used to avoid Conflicts and manage them.
CO2: Apply the basic principles of Dispute Resolution expeditiously.
CO3: Be involved in range of dispute resolution techniques including Adjudication and Arbitration proceedings.
CO4: Display knowledge about conflict management and dispute resolution procedures including negotiation, mediation and conciliation, adjudication, arbitration and litigation.

Books and References

1. A Guide to Quantity Surveyors, Engineers Architects and Builders(Vol I: Taking off quantities, abstracting & Billing; Vol II: Analysis of Prices) by Kharb, K.S. Sushila Publications.
2. Construction Contracts by Keith Collier, Reston Publishing Company, Inc, Reston,Verginia.
3. Construction Contracts - Law and Management by John Murdoch & Will Hughes, Spon Press, Taylor & Francis Group.
4. Law relating to Building and Engineering Contracts in India by Gajerai, G.T., Butterworths.
5. Govt of India, Central Public Works Department, "CPWD Works Manual 2003."
6. Govt of India, Central Public Works Department, "Analysis of Rates for Delhi (Vol 1 & 2)." And "Delhi Schedule of Rates."
7. Govt of India, Central Public Works Department, "CPWD 7/8: General Conditions of Contracts."
8. Govt of India, Military Engineer Services, "IAFW 2249: General Conditions of Contracts.

Course Name: **Soil- Structures Interaction Analysis**
Course Code: **CE-741**
Course Type: **Programme Elective III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about soil-structure-interaction under different foundations.
- To introduce the analysis and concepts of shallow and deep foundations.
- To enable the students to design shallow foundations embankments, transmission towers, piles and water front structures using advanced analytical techniques and software.

Course Content

Analysis of foundations and flexible retaining structures by conventional method- isolated and combined footings, mats, pile caps, eccentrically loaded foundations, transmission tower foundations, sheet pile walls, Subgrade reaction method, Beam and plate theories, Analysis of footings, mats, pile caps, laterally loaded piles, sheet pile walls, water front structures, Closed form solutions, charts and FEM- footings, mats, reinforced foundations and embankments, Evaluation of relevant material parameters, Use of appropriate software packages.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: To know different types of foundations, their general requirements and loads imposed.
CO2: To learn the analysis of conventional footings.
CO3: To analyze the behavior of pile foundations, transmission towers and water front structures.
CO4: To learn various techniques of soil-structure interaction analysis.
CO5: To understand concepts of soil-structure interaction using advanced analytical techniques and software.
CO6: To use different software techniques in soil-structure interaction analysis.

Books and References

1. Soil-Structure Interaction by A. S. Cakmak, Elsevier
2. Soil-Structure Interaction: Numerical Analysis and Modelling by J.W. Bull, CRC Press.
3. Principles of Geotechnical Engineering by Braja M. Das, Thomson

Course Name: **Design of Substructures**
Course Code: **CE-742**
Course Type: **Programme Elective III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about limit state design of foundations.
- To introduce the analysis and concepts of shallow and deep foundations as well as retaining walls.
- To enable the students to design shallow, pile and well foundations and retaining structures.

Course Content

Introduction to Limit State Design of reinforced concrete in foundations; Soil pressure for structural design; Conventional structural design of continuous footings, individual footings, combined footings and rafts of various types subjected to vertical and lateral loads and moments; Design of circular rafts; Soil structure interaction and 'flexible' approach to the design of foundations; Structural design of piles including pile caps, under-reamed piles, piers and caissons; Structural design of retaining walls, Codal provisions.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: To know about the general requirements, loads imposed and limit state design of foundations.
CO2: To learn the analysis of foundations.
CO3: To perform structural design of different types of footings.
CO4: To design pile and well foundations.
CO5: To envisage the structural design of retaining structures.

Books and References

1. Design of Sub-structures by Swami Saran, Oxford & Ibh Publishing Co Pvt Ltd.
2. Principles of Geotechnical Engineering by Braja M. Das, Thomson.
3. Analysis & Design Of Substructures by Swami saran, Oxford & Ibh Publishing Co. Pvt Ltd.

Course Name: **Disaster Management**
Course Code: **CE-723**
Course Type: **Programme Elective III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about the disaster Management
- To introduce the fundamental concepts relevant to various aspect of disaster
- To enable the students to understand the factors that causes the disaster.
- To be able to assess risk and vulnerability for natural and man made hazard

Course Content

Introduction to Natural & Man-made Disasters : Understanding Disasters, Geological and Mountain Area Disasters, Wind and Water Related Natural Disaster, Man Made Disasters

Technologies for Disaster Management Role of IT in Disaster Preparedness, Remote Sensing, GIS and GPS, Use and Application of Emerging Technologies, Application of Modern Technologies for the Emergency communication, Application and use of ICST for different disasters.

Rehabilation, Reconstruction and Recovery: Introduction and basic concept:

Disaster Response And Management: Introduction to Response Essential Components, Stakeholders Co-ordination in Disaster Response, Human Behaviour and Response Management and Relief Measures

Behaviour and Response Management and Relief Measures

Disaster Mitigation : meaning and concept, Disaster Mitigation Strategies, Emerging Trends in Disaster Mitigation, Mitigation management, Role of Team and Coordination.

Course Outcomes

After learning the course the students should be able to:

CO1: Understand disasters, disaster preparedness, role of IT, remote sensing, GIS and GPS,
CO2: Understand Rehabilitation, Reconstruction And Recovery,
CO3: Apply knowledge Disaster Response And Management, Risk Assessment and Vulnerability Analysis,
CO4: Understand Disaster Mitigation.

Books and References

1. Natural Hazards by Bryant Edwards, Cambridge University Press, U.K.
2. Disaster Management by Carter, W. Nick, Asian Development Bank, Manila.
3. Disaster Mitigation Experiences and Reflections by Sahni, Pardeep et.al., Prentice Hall of India, New Delhi.
4. Space Technology for Disaster management: A Remote Sensing & GIS Perspective by Roy, P.S., IIRS (NRSA) Dehradun.
5. Natural Disaster by Sharma, R.K. & Sharma, G, APH Publishing Corporation, New Delhi.
6. Disaster Management in the Hills by Singh Satendra, Concept Publishing Company, New Delhi.
7. Disaster Management through Panchayati Raj by Taori, K, Concept Publishing Company, New Delhi.

Course Name: **Finite Element Method**
Course Code: **CE-724**
Course Type: **Programme Elective III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To learn basic principles of finite element analysis procedure.
- To learn the theory and characteristics of finite elements that represent engineering structures
- Learn to model complex geometry problems and solution techniques
- To learn and apply finite element solutions to Structural Engineering problem

Course Content

Approximate methods of Analysis, Introduction, Steps in finite element, Different approaches in FEM- Direct, Variational, Energy, Weighted residual,1-D FE Analysis- bar element, truss element, Beam element and Frame element, 2-D FE Analysis-CST element for plane stress and plane strain, Axis symmetry case,4-node rectangular element, Langrangian interpolation function, 3-D FE Analysis- brick element, Assembling, iso-parametric formulations, Use of Symmetric and anti-symmetric condition.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the concepts various approaches in FEM.
CO2: Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element
CO3: Apply FEM in different fields like, seepage proble, heat transfer etc.
CO4: Develop element level equation and generate global stiffness equation for the engineering problem

Books and References

1. Finite Element Analysis: Theory and Programming by C.S. Krishnamoorty, Tata McGraw-Hill Education
2. Introduction to Finite Elements in Engineering by T. R. Chandrupatla, A. D. Belegundu, Pearson Education Limited
3. Fundamentals Of Finite Element Analysis by D. V.Hutton, Tata McGraw-Hill Education
4. Finite element methods, Vol I & Vol II, O.C. by Zienkiewicz and R.L. Taylor, McGraw Hill.
5. Finite element procedures by K. J. Bathe, PHI Ltd.
6. Concepts and applications of finite element analysis by R.D.Cook, Malkus and M.E. Plesha, Wiley and Sons.

Course Name: **Reinforced Soil Structures**
Course Code: **CE-745**
Course Type: **Programme Elective IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

1. Know about the methods and design of right kind of ground improvement techniques required for the actual field situation
2. Know about the types, functions, application and designing with geosynthetics

Course Content

Introduction: Types and functions; Materials and manufacturing processes; Testing and evaluations
Principles of soil reinforcement: Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures – walls and slopes, Codal provisions.
Applications: Bearing capacity improvement, embankments on soft soils, Indian experiences, Geosynthetics in Pavements, Geosynthetics in roads and railways, separations, drainage and filtering in road pavements and railway tracks, overlay design and construction.
Geosyhtetics in environmental geotechnics and guidelines: AASHTO and other relevant guidelines, trench drains, Geosynthetics in Environmental Control, Liners for ponds and canals, covers and liners for landfills – material aspects and stability considerations, Landslides – occurrences and methods of mitigation; Erosion – causes and techniques for control.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the basic mechanics of the designing with geosynthetics

CO2: Apply the knowledge to appropriate field situation

Books and References

1. Geosynthetics and Their Applications by S. K. Shukla and J.H Yin, CRC Press.
2. Reinforced Soil Engineering: Advances in Research and Practice by Hoe I. Ling, Dov Leshchinsky, Fumio Tatsuoka, Marcel Dekker, Inc.
3. Earth Reinforcement and Soil Structures by Colin John Francis Phillip Jones, Butterworths & Co.

Course Name: **Rock Slope Engineering**
Course Code: **CE-746**
Course Type: **Programme Elective IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

1. Analyze the stability of rock slopes
2. Learn about the stabilisation of rock slopes
3. Learn about the design procedures for dealing with structurally controlled instabilities in rock slope engineering

Course Content

Principles of rock slope design: Introduction, Socioeconomic consequences of slope failures, Principles of rock slope engineering, Open pit mining slope stability, Slope features and dimensions, Rock slope design methods such as Limit equilibrium analysis , Sensitivity analysis, Probabilistic design methods,Load and resistance factor design.

Structural geology and data interpretation: Objectives of geological investigations, Mechanism of joint formation, Effects of discontinuities on slope stability, Orientation of discontinuities, Stereographic analysis of structural geology, Stereographic projection, Pole plots and contour plots, Pole density, Great circles, Lines of intersection, Identification of modes of slope instability, Kinematic analysis, Applications of kinematic analysis, site investigation and geological data collection

Stability of Rock slopes: Plane failure, wedge failure, circular failure and toppling failure.

Blasting and stabilization of rock slopes: Introduction, Mechanism of rock fracturing by explosives, Production blasting, Explosive properties, Bench height, Burden, Blast hole diameter, Nature of the rock, Sub-drill depth,Stemming, Hole spacing, Hole detonation sequence, Fragmentation,Evaluation of a blast, Controlled blasting to improve stability,Pre-shearing and cushion blasting, Drilling, Explosive load, Stemming, Spacing and burden, Blast damage and its control , Damage from ground vibration, Control of flyrock , Control of air blast and noise and movement monitoring

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Learn the stabilisation and design of reinforcement for the rock slopes

Books and References

1. Rock Slope Engineering by Duncan C. Wyllie and Christopher W. Mah CRC Press.
2. Rock Slope Stability by Charles A. Kliche, Society for Mining Metallurgy.
3. Underground excavations in rock by Evert Hoek, CRC press.

Course Name: **Optimization Methods**
Course Code: **CE-727**
Course Type: **Programme Elective IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about the optimization
- To impart knowledge about the multi-objective nature of Engineering Design
- To Apply optimization methods to solve the Engineering Design Problems

Course Content

Basics of engineering analysis and design, Need for optimal design, formulation of optimization problem, classical-simplex search, gradient search, Newton Raphson and global Optimization techniques-Introduction to GA, Constrained and Unconstrained optimization problems, Convex optimization, Sensitivity analysis, Numerical methods for nonlinear optimization problems.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understanding the basic concepts of classical optimization
CO2: Analysis of optimization algorithms
CO3: Applications of optimization in Civil Engineering

Books and References

1. Optimization for engineering design: Algorithms and examples by K. Deb, PHI Pvt Ltd.
2. Introduction to optimum design by J.S. Arora, McGraw Hill International editions.
3. Elements of structural optimization by R.T. Hafta and Z. Gurdal, Kluwer academic publishers.
4. Engineering Optimization theory and Practice by S. S. Rao, New Age International.

Course Name : **Project Planning and Scheduling**
Course Code : **CE-728**
Course Type : **Programme elective IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- Understanding the need of project planning,
- Understanding concept of bar-chart,
- Understanding planning and scheduling using critical path method,
- Understanding planning and scheduling using PERT and PDM, and
- Understanding scheduling of repetitive construction.

Course Content

Construction Planning: Objectives and functions, stages in construction, work breakdown structure, pre-tender stage planning, contract stage planning, methods of scheduling, bar charts, limitations of bar charts, milestone charts, preparation of material, equipment, labour, and finance schedule. Critical Path Method (CPM): Network techniques, element of a network, rules for developing networks, development logics, numbering events, time computations, activity floats, network updating. Resources profile, resources smoothing and resources leveling. Cost versus time, direct cost, indirect cost, total project cost, optimum duration, contracting network for cost optimization.

Programme Evaluation and Review Technique (PERT): Probability concept in network, optimistic time, pessimistic time, most likely time, variance, standard deviation, slack, central limit theorem, probability of achieving completion time.

Precedence Diagram Method (PDM): Precedence networks fundamentals, advantages, logic and precedence networks applications, PDM versus CPM. Line of Balancing (LOB) technique in the construction scheduling: Line of balance methods of scheduling repetitive construction.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Plan and schedule by bar-chart,
CO2: Understand the principles of critical path method,
CO3: Apply PERT and PDM to solving problems of Civil Engineering planning, and
CO4: Apply LOB to solving problems of repetitive construction planning

Books and References

1. Construction Project Management, Planning scheduling and controlling by Chitkara, K.K., Tata McGraw-Hill Education.
2. Project Management with CPM and PERT, and precedence diagramming by Moder J.J. Philips, C.R. and Davis, E.W., Van Nostrand Reinhold
3. Project Cost Control in Construction by Pilcher, R. Brien J.J. CPM in “Construction Management”, Mc. Graw Hill.